

## 4. PERIODIC TABLE OF THE ELEMENTS

**Table 4.1.** Revised 2007 by C.G. Wohl (LBNL) and D.E. Groom (LBNL). Adapted from the Commission on Isotopic Abundances and Atomic Weights, “Atomic Weights of the Elements 2005,” Pure and Applied Chemistry **78**, 2051 (2006), and G. Audi, A.H. Wapstra, and C. Thibault, Nucl. Phys. **A729**, 337 (2003). The atomic number (top left) is the number of protons in the nucleus. The atomic mass (bottom) is weighted by isotopic abundances in the Earth’s surface. Atomic masses are relative to the mass of  $^{12}\text{C}$ , defined to be exactly 12 unified atomic mass units (u) (approx. g/mole). Relative isotopic abundances often vary considerably, both in natural and commercial samples; this is reflected in the number of significant figures given. A number in parentheses is the atomic mass of the longest-lived known isotope of that element as of 2005—no stable isotope exists. The exceptions are Th, Pa, and U, which do have characteristic terrestrial compositions. As of early 2006 element 112 has not been assigned a name, and there are no confirmed elements with  $Z > 112$ .

| 1<br>IA                    | PERIODIC TABLE OF THE ELEMENTS |                                |                               |                        |                        |                           |                           |                           |                              |                            |                        |                         |                     |                         |                           |                           |                        |  |
|----------------------------|--------------------------------|--------------------------------|-------------------------------|------------------------|------------------------|---------------------------|---------------------------|---------------------------|------------------------------|----------------------------|------------------------|-------------------------|---------------------|-------------------------|---------------------------|---------------------------|------------------------|--|
| 1 H<br>Hydrogen<br>1.00794 | 2 He<br>Helium<br>4.002602     | 3 Li                           | 4 Be                          | 5 B                    | 6 C                    | 7 N                       | 8 O                       | 9 F                       | 10 Ne                        | 11 Na                      | 12 Mg                  | 13 Al                   | 14 Si               | 15 P                    | 16 S                      | 17 Cl                     | 18 Ar                  |  |
| 3 Lithium<br>6.941         | 4 Beryllium<br>9.012182        | 5 Boron<br>10.811              | 6 Carbon<br>12.0107           | 7 Nitrogen<br>14.0067  | 8 Oxygen<br>15.9994    | 9 Fluorine<br>18.9984032  | 10 Neon<br>20.1797        | 11 Sodium<br>22.98976928  | 12 Magnesium<br>24.3050      | 13 Aluminum<br>26.9815386  | 14 Silicon<br>28.0855  | 15 Phosph.<br>30.973762 | 16 Sulfur<br>32.065 | 17 Chlorine<br>35.453   | 18 Argon<br>39.948        |                           |                        |  |
| 19 Potassium<br>39.0983    | 20 Calcium<br>40.078           | 21 Scandium<br>44.955912       | 22 Titanium<br>47.867         | 23 Vanadium<br>50.9415 | 24 Chromium<br>51.9961 | 25 Manganese<br>54.938045 | 26 Iron<br>55.845         | 27 Cobalt<br>58.933195    | 28 Nickel<br>58.6934         | 29 Copper<br>63.546        | 30 Zinc<br>65.409      | 31 Gallium<br>69.723    | 32 German.<br>72.64 | 33 Arsenic<br>74.92160  | 34 Selenium<br>78.96      | 35 Bromine<br>79.904      | 36 Krypton<br>83.798   |  |
| 37 Rubidium<br>85.4678     | 38 Strontium<br>87.62          | 39 Yttrium<br>88.90585         | 40 Zirconium<br>91.224        | 41 Niobium<br>92.90638 | 42 Molybd.<br>95.94    | 43 Technet.<br>(97.9072)  | 44 Ruthen.<br>101.07      | 45 Rhodium<br>102.90550   | 46 Palladium<br>106.42       | 47 Silver<br>107.8682      | 48 Cadmium<br>112.411  | 49 Indium<br>114.818    | 50 Tin<br>118.710   | 51 Antimony<br>121.760  | 52 Tellurium<br>127.60    | 53 Iodine<br>126.90447    | 54 Xenon<br>131.293    |  |
| 55 Cesium<br>132.9054519   | 56 Barium<br>137.327           | 57–71 Lanthanides<br>178.49    | 72 Hafnium<br>180.94788       | 73 Tantalum<br>183.84  | 74 Tungsten<br>186.207 | 75 Rhenium<br>190.23      | 76 Osmium<br>192.217      | 77 Iridium<br>195.084     | 78 Platinum<br>196.966569    | 79 Gold<br>200.59          | 80 Mercury<br>204.3833 | 81 Thallium<br>204.3833 | 82 Lead<br>207.2    | 83 Bismuth<br>208.98040 | 84 Polonium<br>(208.9824) | 85 Astatine<br>(209.9871) | 86 Radon<br>(222.0176) |  |
| 87 Francium<br>(223.0197)  | 88 Radium<br>(226.0254)        | 89–103 Actinides<br>(267.1215) | 104 Rutherford.<br>(268.1255) | 105 Dubnium<br>(266.)  | 106 Seaborg.<br>(264.) | 107 Bohrium<br>(277.150)  | 108 Hassium<br>(276.1512) | 109 Meitner.<br>(281.162) | 110 Darmstadt.<br>(280.1645) | 111 Roentgen.<br>(285.174) |                        |                         |                     |                         |                           |                           |                        |  |

|                   |                                 |                               |                                  |                              |                                  |                                  |                                |                               |                                  |                                  |                                  |                                 |                                   |                                  |                                  |
|-------------------|---------------------------------|-------------------------------|----------------------------------|------------------------------|----------------------------------|----------------------------------|--------------------------------|-------------------------------|----------------------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|----------------------------------|----------------------------------|
| Lanthanide series | 57 La<br>Lanthan.<br>138.90547  | 58 Ce<br>Cerium<br>140.116    | 59 Pr<br>Praseodym.<br>140.90765 | 60 Nd<br>Neodym.<br>144.242  | 61 Pm<br>Prometh.<br>(144.9127)  | 62 Sm<br>Samarium<br>150.36      | 63 Eu<br>Europium<br>151.964   | 64 Gd<br>Gadolin.<br>157.25   | 65 Tb<br>Terbium<br>158.92535    | 66 Dy<br>Dyspros.<br>162.500     | 67 Ho<br>Holmium<br>164.93032    | 68 Er<br>Erbium<br>167.259      | 69 Tm<br>Thulium<br>168.93421     | 70 Yb<br>Ytterbium<br>173.04     | 71 Lu<br>Lutetium<br>174.967     |
| Actinide series   | 89 Ac<br>Actinium<br>(227.0278) | 90 Th<br>Thorium<br>232.03806 | 91 Pa<br>Protactin.<br>231.03588 | 92 U<br>Uranium<br>238.02891 | 93 Np<br>Neptunium<br>(237.0482) | 94 Pu<br>Plutonium<br>(244.0642) | 95 Am<br>Americ.<br>(243.0614) | 96 Cm<br>Curium<br>(247.0704) | 97 Bk<br>Berkelium<br>(247.0703) | 98 Cf<br>Californ.<br>(251.0796) | 99 Es<br>Einstein.<br>(252.0830) | 100 Fm<br>Fermium<br>(257.0951) | 101 Md<br>Mendelev.<br>(258.0984) | 102 No<br>Nobelium<br>(259.1010) | 103 Lr<br>Lawrenc.<br>(262.1096) |